AI Research

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Thanks to the slides from Prof. Hung-Yi Lee in NTU.

How do you do a AI research?

- Read latest papers.
- Find the current issues of AI.
- Prepare datasets.
- Find appropriate models and modify models.
- Evaluate the performance of models.

Read Latest Papers

- AAAI https://aaai.org/Conferences/AAAI-21/
- CVPR http://cvpr2021.thecvf.com/
- NIPS https://nips.cc/Conferences/2021/Dates

- Find other conferences: Guide2Research
- https://www.guide2research.com/

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What is the current issues of AI Research? (1/3)

- Issue1: Data is few. Data is diverse. (少量多樣)

iphone 7 iphone 7+ iphone X iphone 12

What is the current issues of AI Research? (2/3)

- There are many new data. When model updates for new data, model forgets old data.

F** can not calculate addition and subtraction

What is the current issues of AI Research? (3/3)

- Labeling takes a lot of labor and time.

  Mura 是指顯示器亮度不均勻造成各種痕跡的現象

(a1) 正常影像

(a2) Gravity mura

(a3) Spot mura

(a4) Ring mura

(a5) Weak-line mura

Can you classify the mura without defect labels?

http://machinevision.iem.yzu.edu.tw/vision/thesis/94_Wu/95_Wu.htm

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Prepare Dataset

- The industry cooperation projects.
- Since the AI conference requests data and source code, open data is better.

- Aidea https://aidea-web.tw/
- Kaggle https://www.kaggle.com/

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The Current Issues of AI

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Model to Solve Issue 1

- How do we make model can learn the techniques of learning?

Meta Learning

Introduction

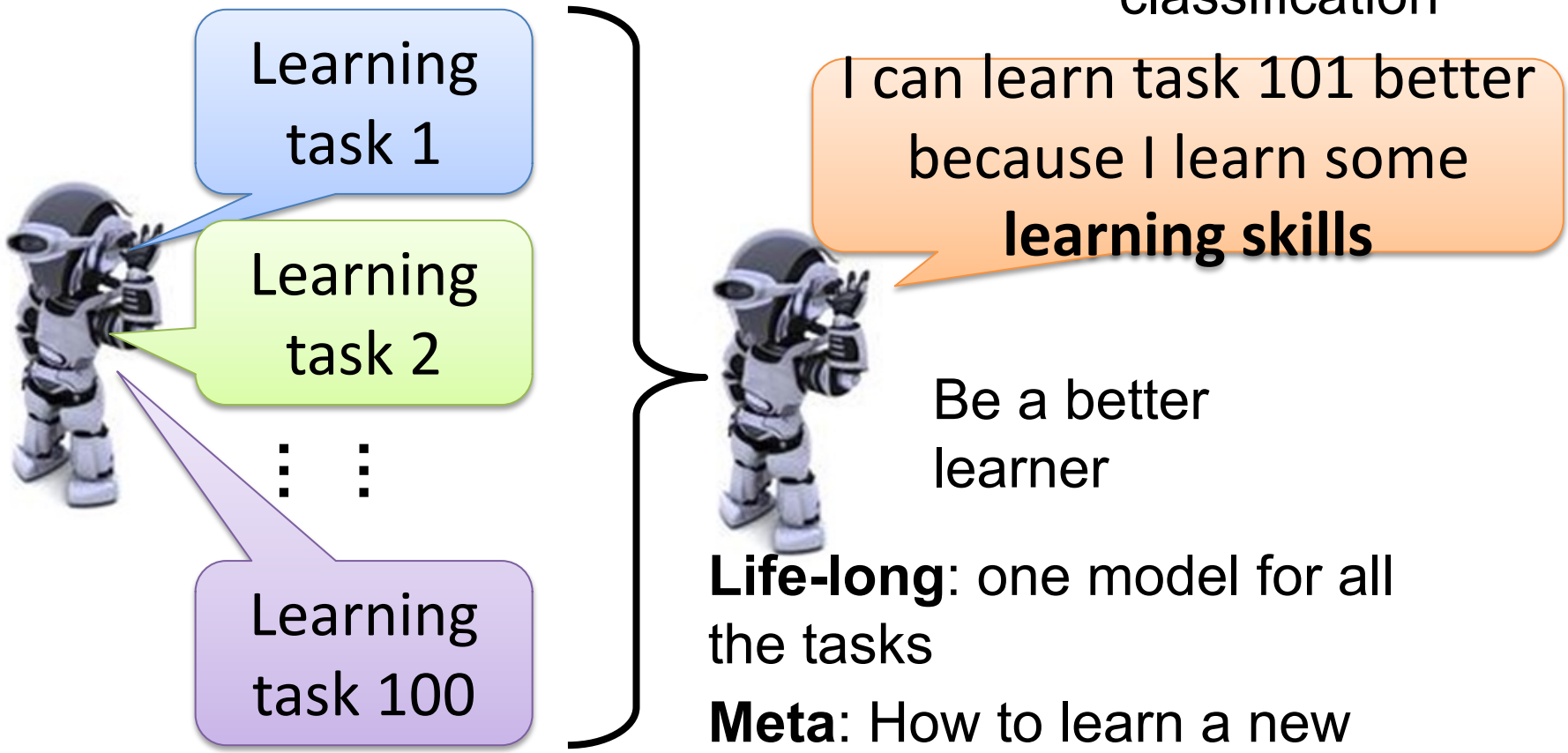
Task 1: speech recognition

Task 2: image recognition

⋮

Task 100: text classification

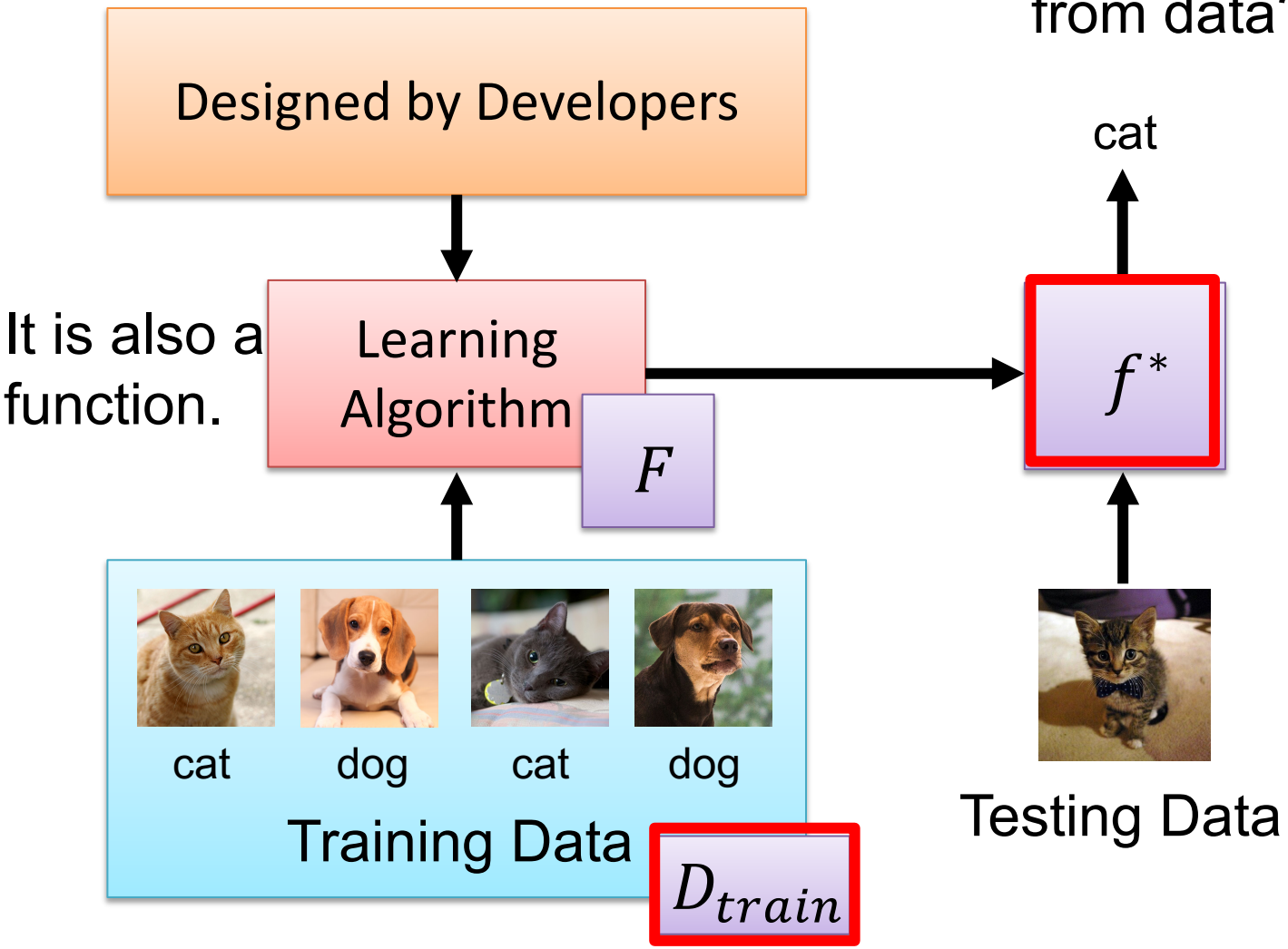
- Meta learning = Learn to learn



Meta Learning

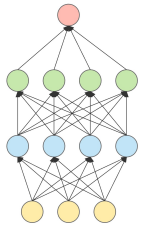
$$f^* = F(D_{train})$$

Can machine find F from data?



Meta Learning

Machine Learning ≈ 根據資料找一個函數 f 的能力

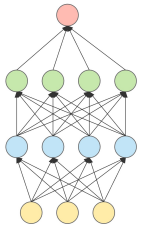


$f($  $) =$ “Cat”

Meta Learning

≈ 根據資料找一個找一個函數 f 的函數 F 的能力

$F($ 

$) = f^*$ 

~~Machine~~ Learning is Simple

Meta

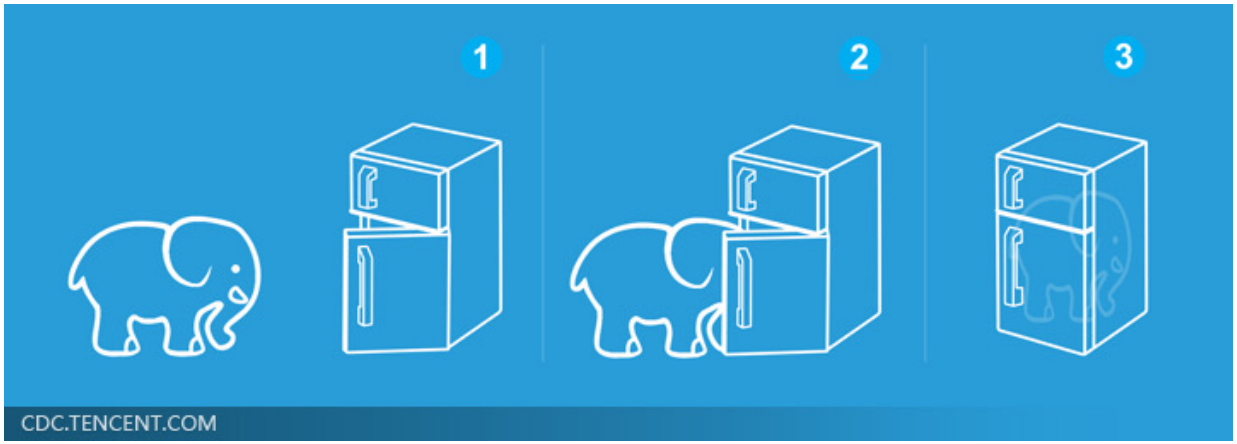
Step 1: define a set of ~~function~~

Step 2: goodness of ~~function~~

Step 3: pick the best ~~function~~

Function f ➡ Learning algorithm F

就好像把大象放進冰箱 .....

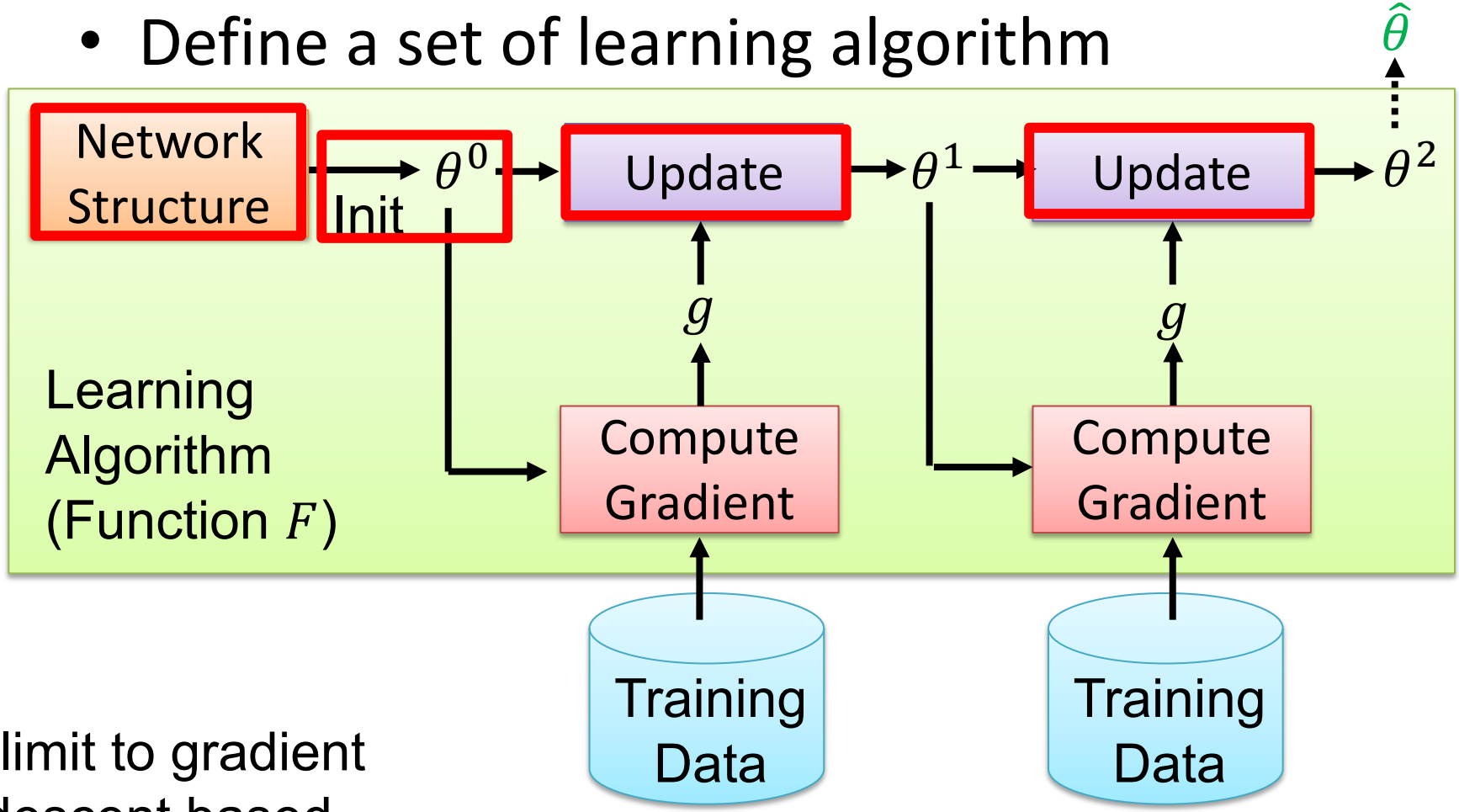


Different decisions in the red boxes lead to different algorithms.

What happens in the red boxes is decided by humans until now.

Meta Learning

- Define a set of learning algorithm



(limit to gradient descent based approach)

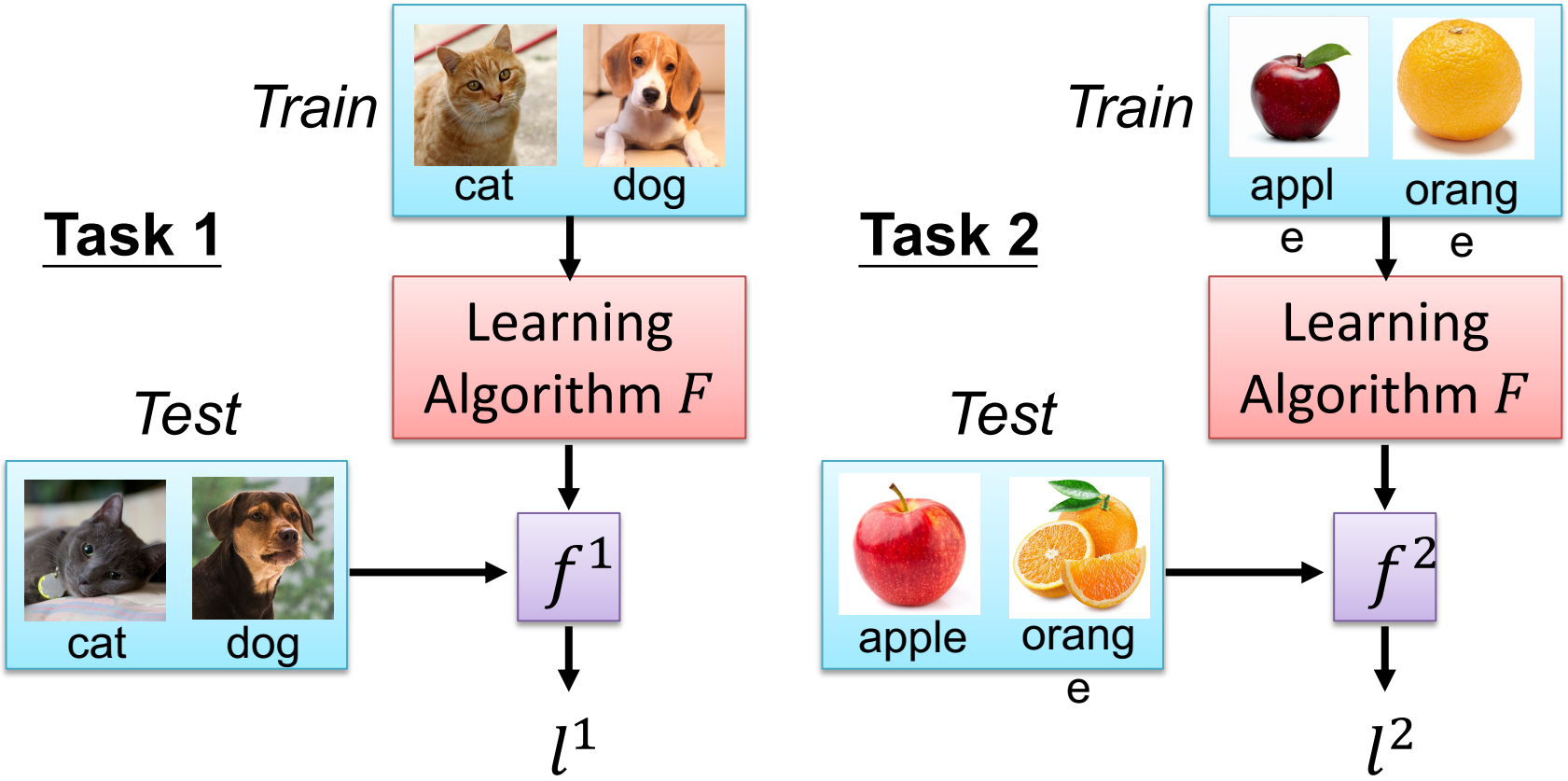
Meta Learning

$$L(F) = \sum_{n=1}^{N} l^n$$

N tasks

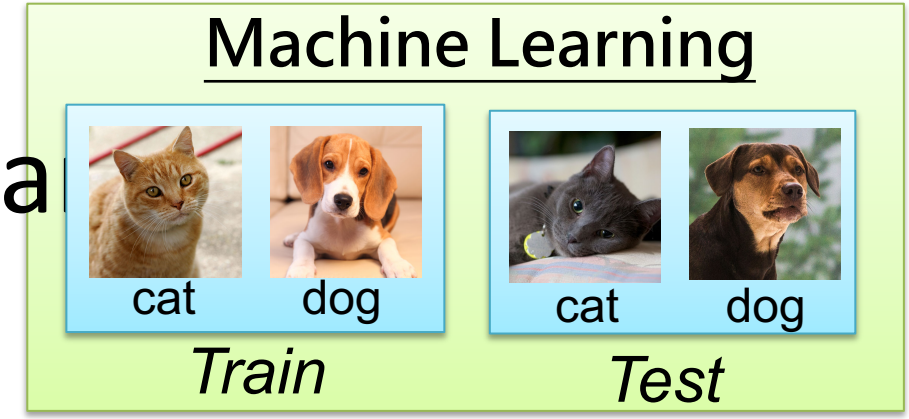
Testing loss for task n after training

- Defining the goodness of a function F



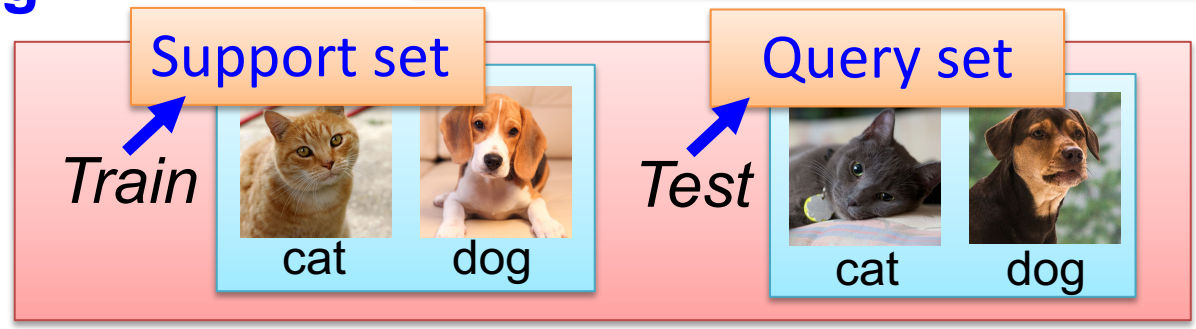
Meta Lea

Widely considered in
few-shot learning

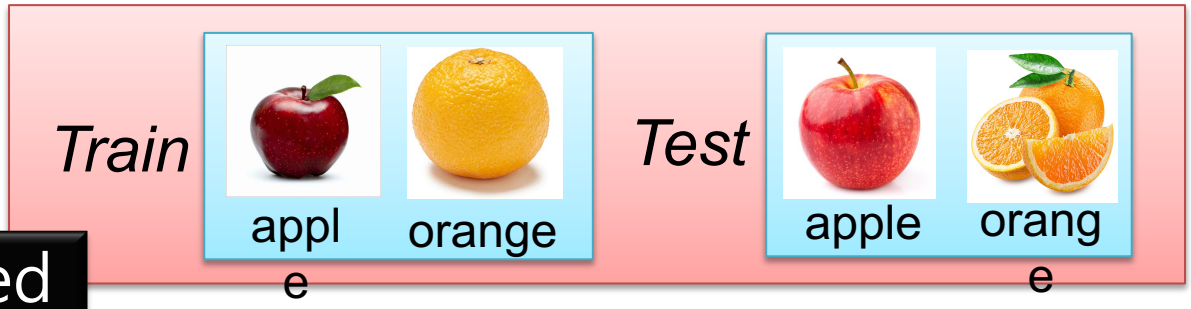


Training Tasks

Task 1

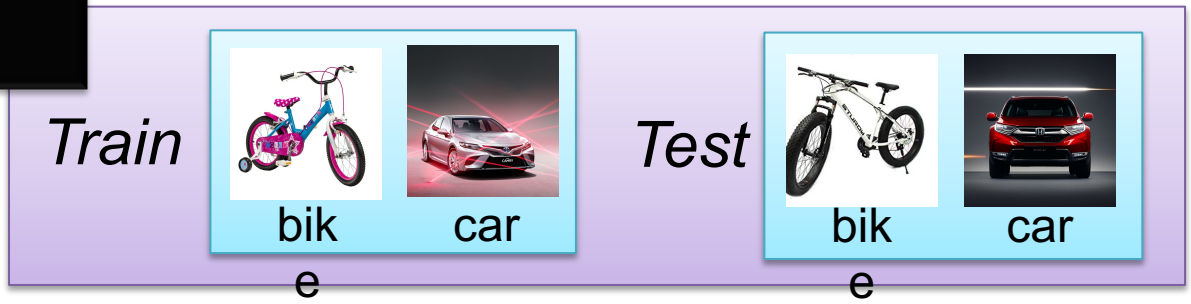


Task 2



Sometimes you need validation tasks

Testing Tasks



Meta Learning

- Defining the goodness of a function F

$$L(F) = \sum_{n=1}^{N} l^n$$

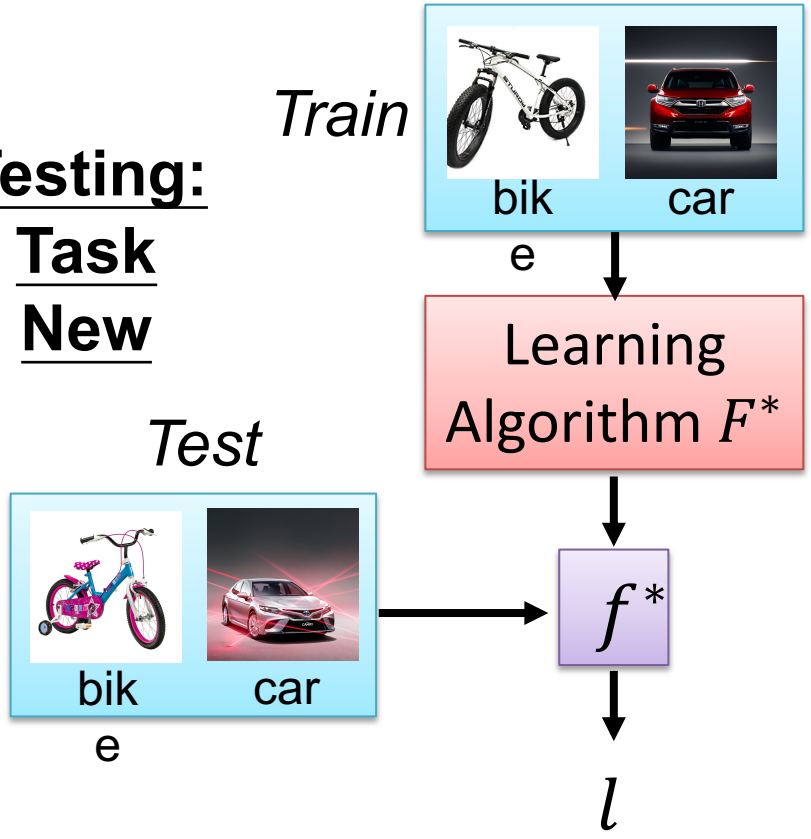
- Find the best function F^*

$$F^* = arg \min_F L(F)$$

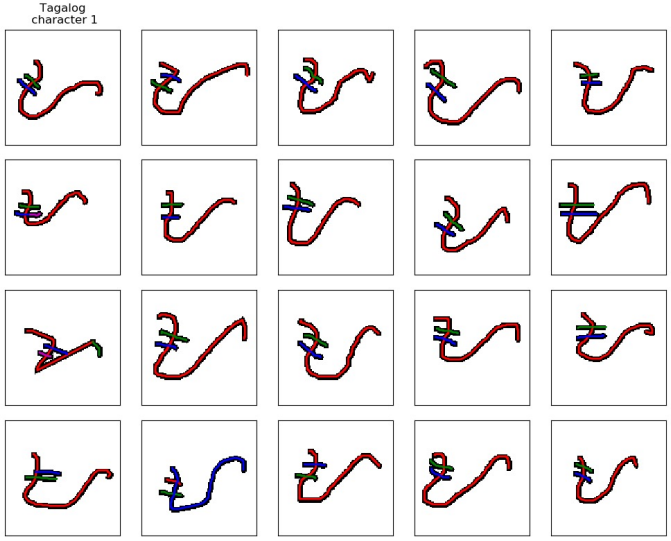
Testing:

Task

New



Omniglot



https://github.com/brendenlake/omniglot

- 1623 characters
- Each has 20 examples

Omniglot – Few-shot Classification

Demo of Reptile: https://openai.com/blog/reptile/

- N-ways K-shot classification: In each training and test tasks, there are N classes, each has K examples.

20 ways
1 shot

Each character represents a class

Testing set (Query set)

Training set (Support set)

- Split your characters into training and testing characters
  - Sample N training characters, sample K examples from each sampled characters → one training task
  - Sample N testing characters, sample K examples from each sampled characters → one testing task

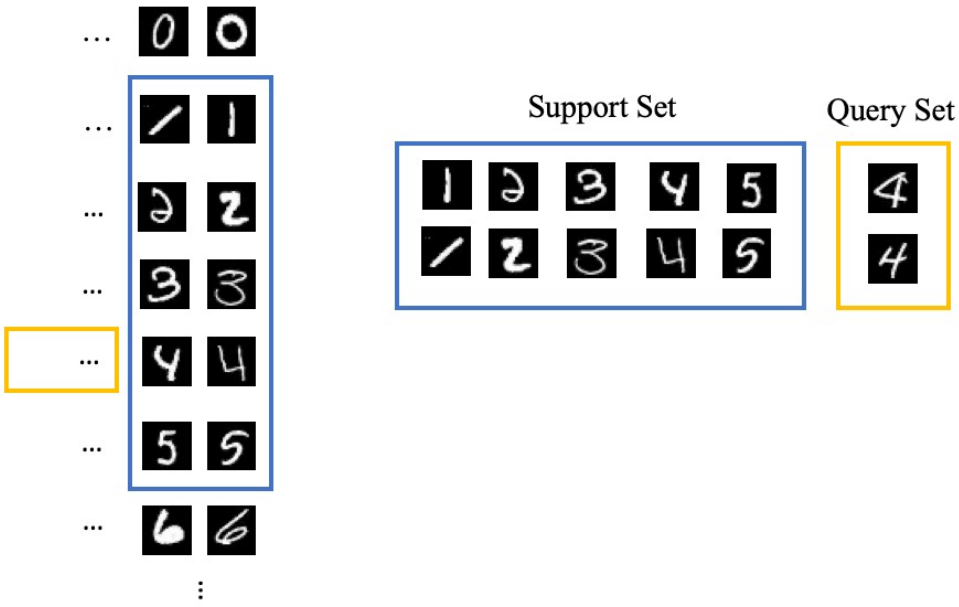
Meta Learning Model

- Siamese Network [1]
- Matching Network [2]
- Prototypical Network [3]
- Relation Network [4]

[1] Koch G, Zemel R, Salakhutdinov R. Siamese neural networks for one-shot image recognition, ICML deep learning workshop. 2015,
[2] O. Vinyals, C. Blundell, T. Lillicrap, D. Wierstra, et al. Matching networks for one shot learning. In NIPS, 2016.
[3] J. Snell, K. Swersky, and R. S. Zemel. Prototypical networks for few-shot learning. In NIPS, 2017.
[4] F. Sung, Y. Yang, L. Zhang, T. Xiang, P. H. Torr, and T. M. Hospedales. Learning to compare:Relation network for few-shot learning. In CVPR, 2018.

Episodic Training

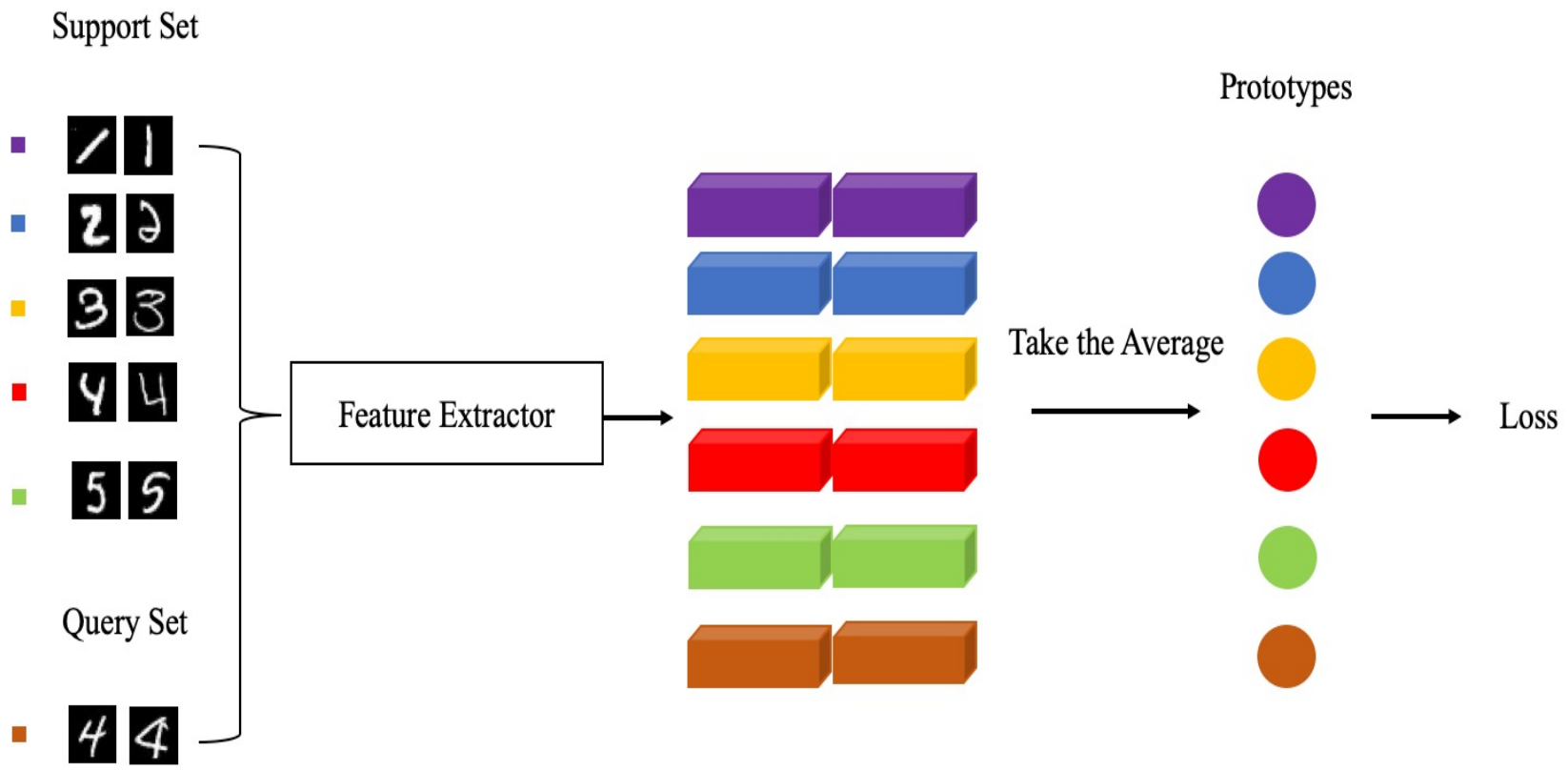
- 模擬真實情況的訓練方式
- K Way C Shot的Episodic Training是在每一個episode挑選出K個類別，每一個類別挑選出C張圖片作為support set，再從K個類別中挑選出一個類別，一樣挑出C張作為query set，並一次以一個episode去做訓練



Prototypical Network (1/2)

- Prototypical Network對於特徵向量做了近一步的思考
- 當圖像被映射至高維空間時，相似的圖像會聚集且具有線性關係。
- 將support set中每個類別的每個特徵向量取平均作為該類別的prototype
- 將query set的每個特徵向量取平均，作為query set的prototype
- 最後計算support set的prototype和query set的prototype之間的負cosine距離當作相似度來訓練模型。

Prototypical Network (2/2)



The Current Issues of AI

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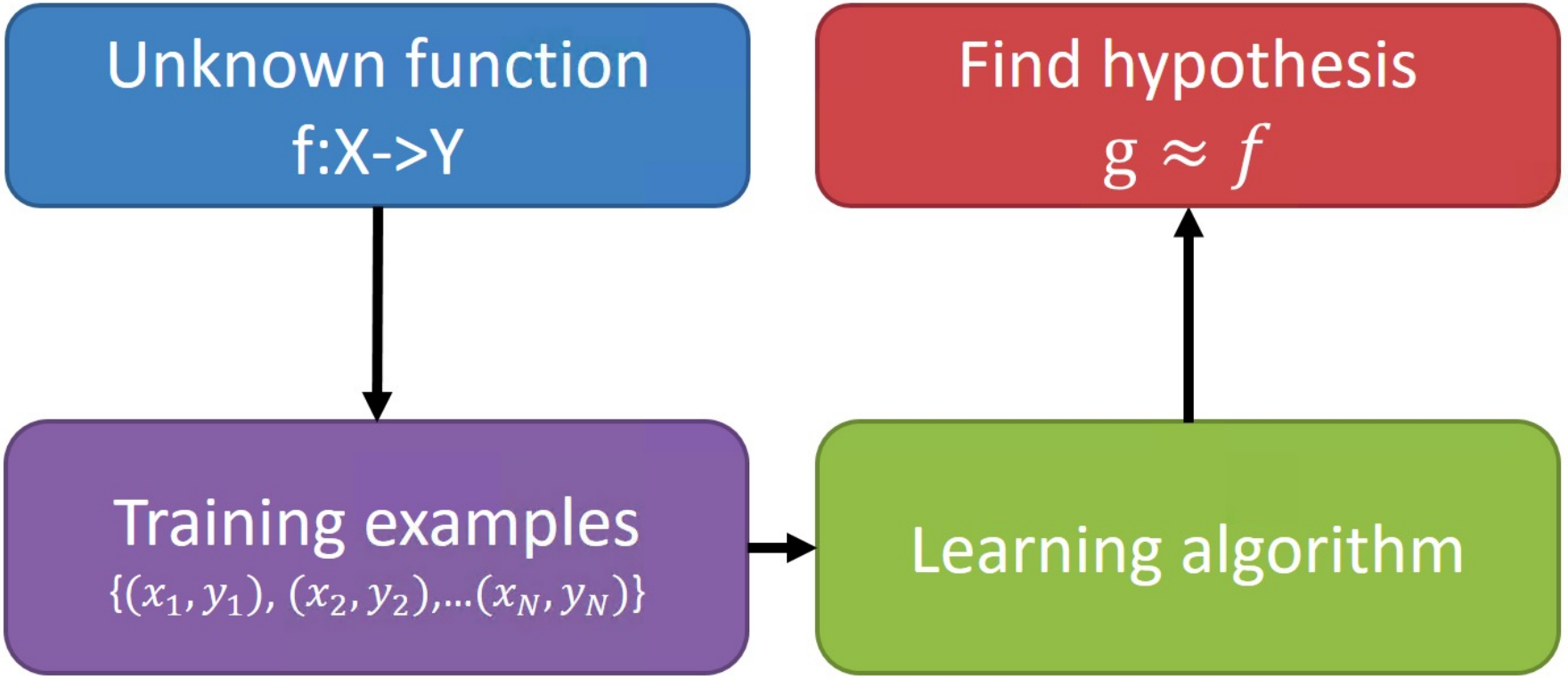
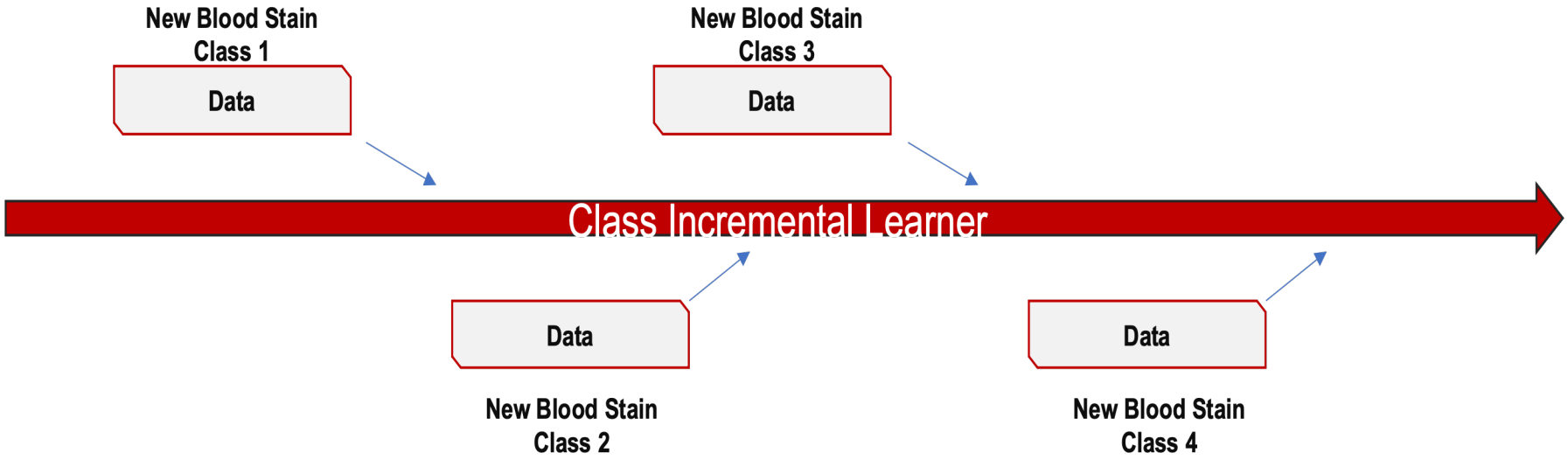
Train a Model



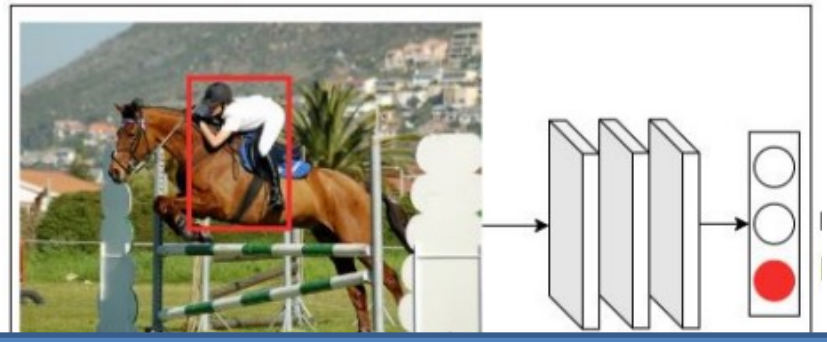
We find the best model f*.

Training Data is Changed

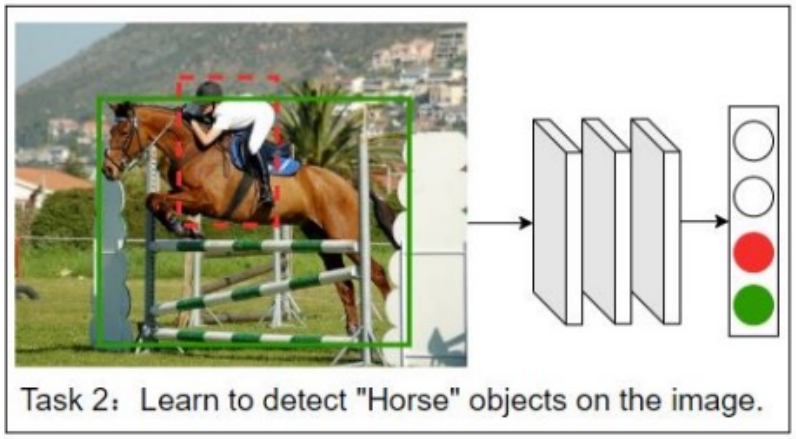
- If the training dataset is changed, we have to train a new model.



Model Forgets Old Class



Incremental Learning
(Continual Learning)



Different Methods of Incremental Learning

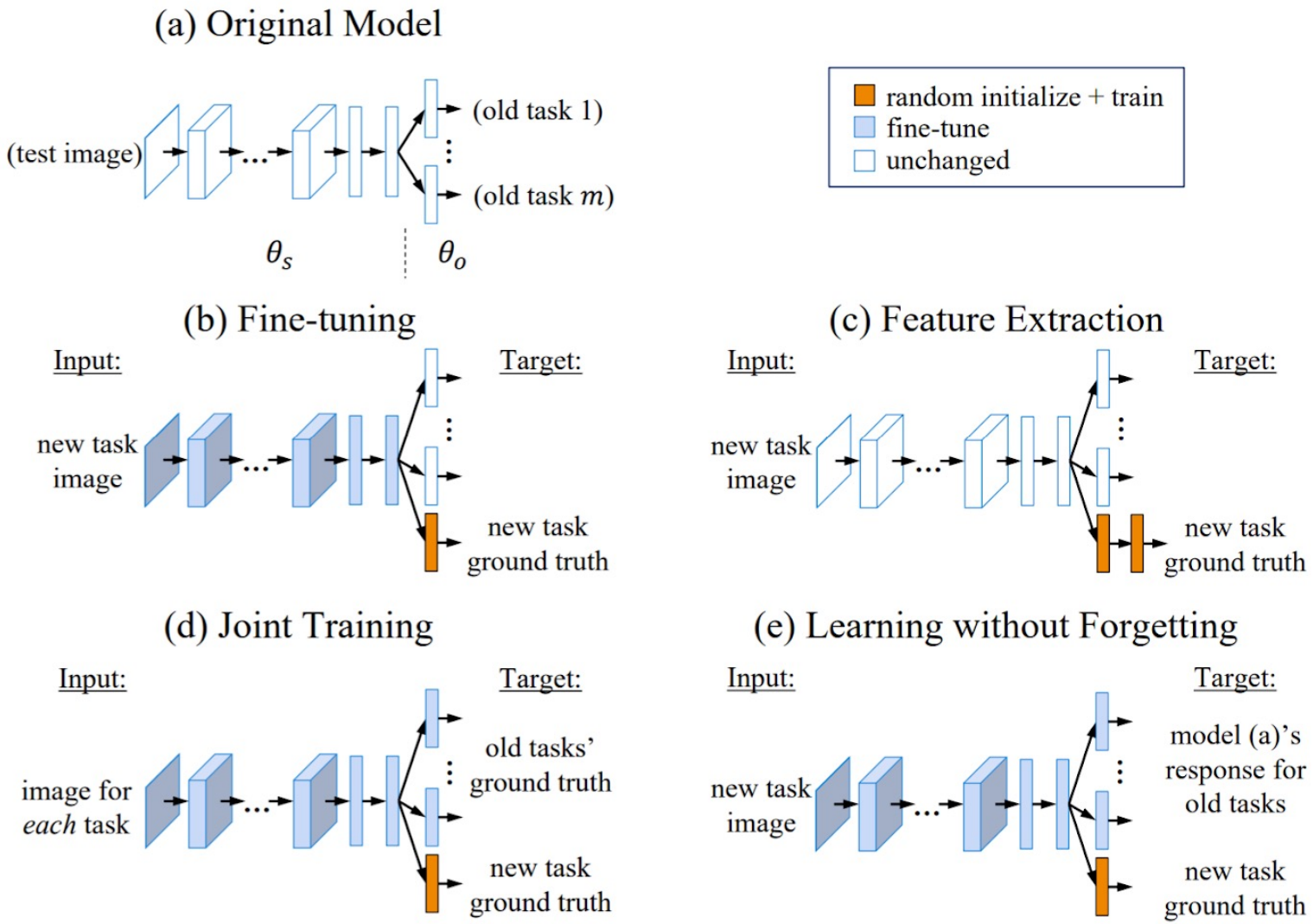


Fig. 2. Illustration for our method (e) and methods we compare to (b-d). Images and labels used in training are shown. Data for different tasks are used in alternation in joint training.

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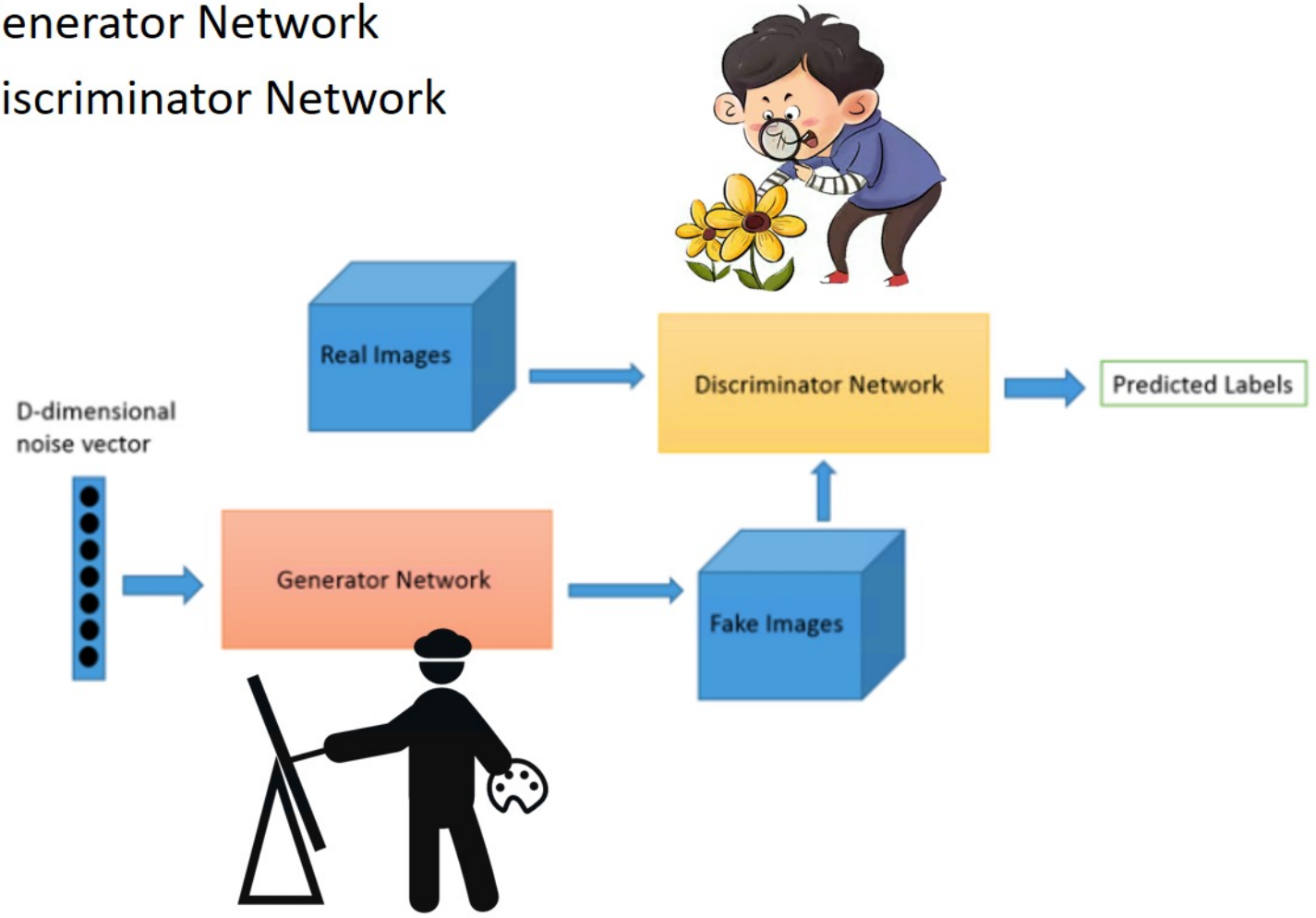
Data Without Label

- What kinds of model can be trained without labeling?

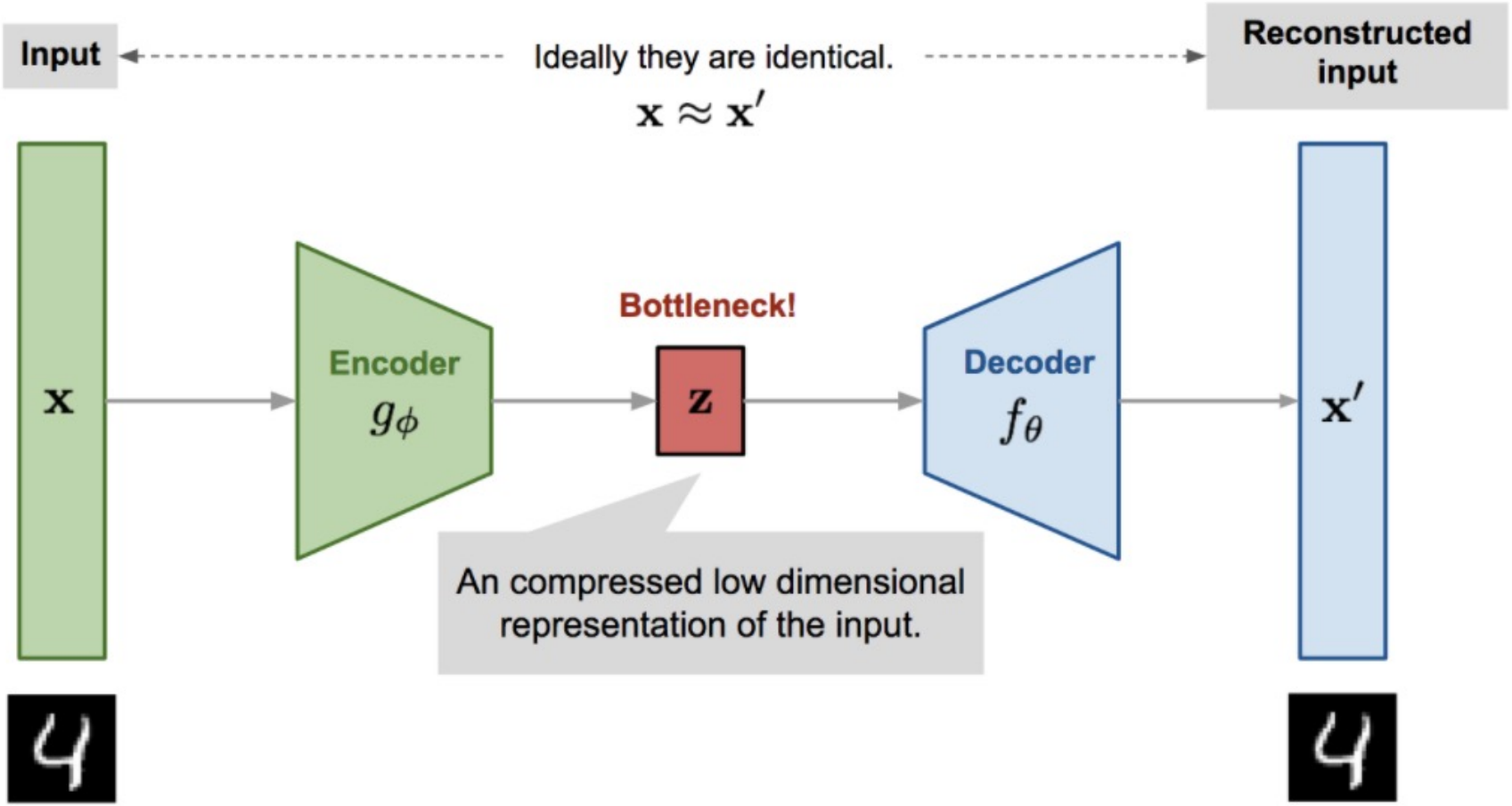
- Unsupervised Learning
- Clustering
- Generative adversarial network
- Autoencoder

Generative Adversarial Network

- GAN:
  - Generator Network
  - Discriminator Network

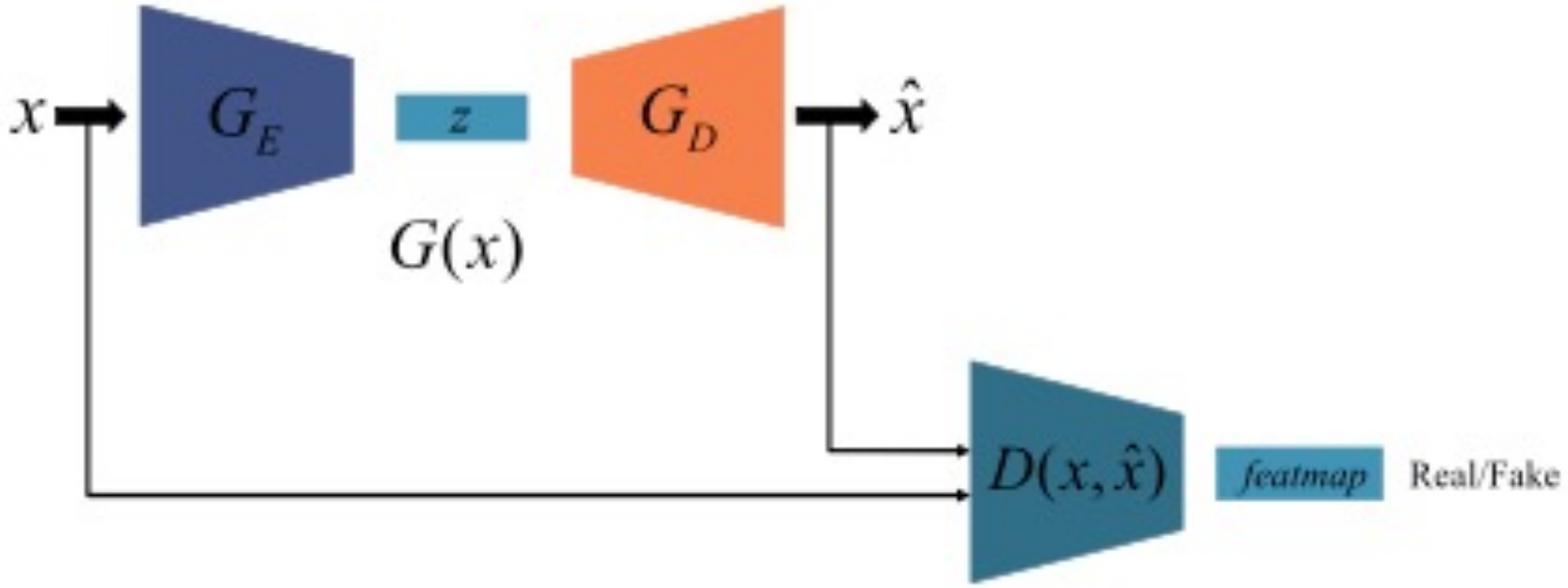


AutoEncoder



Combining GAN and AutoEncoder

- Resnet GAN



Encoder

- Resnet

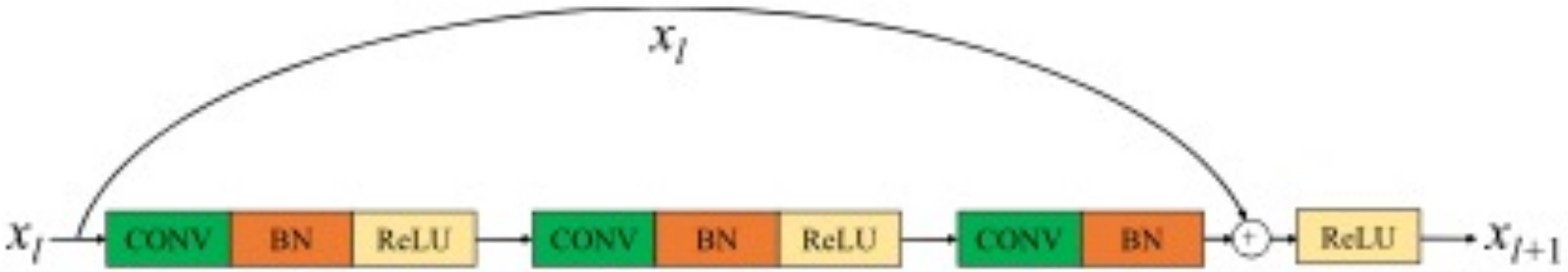
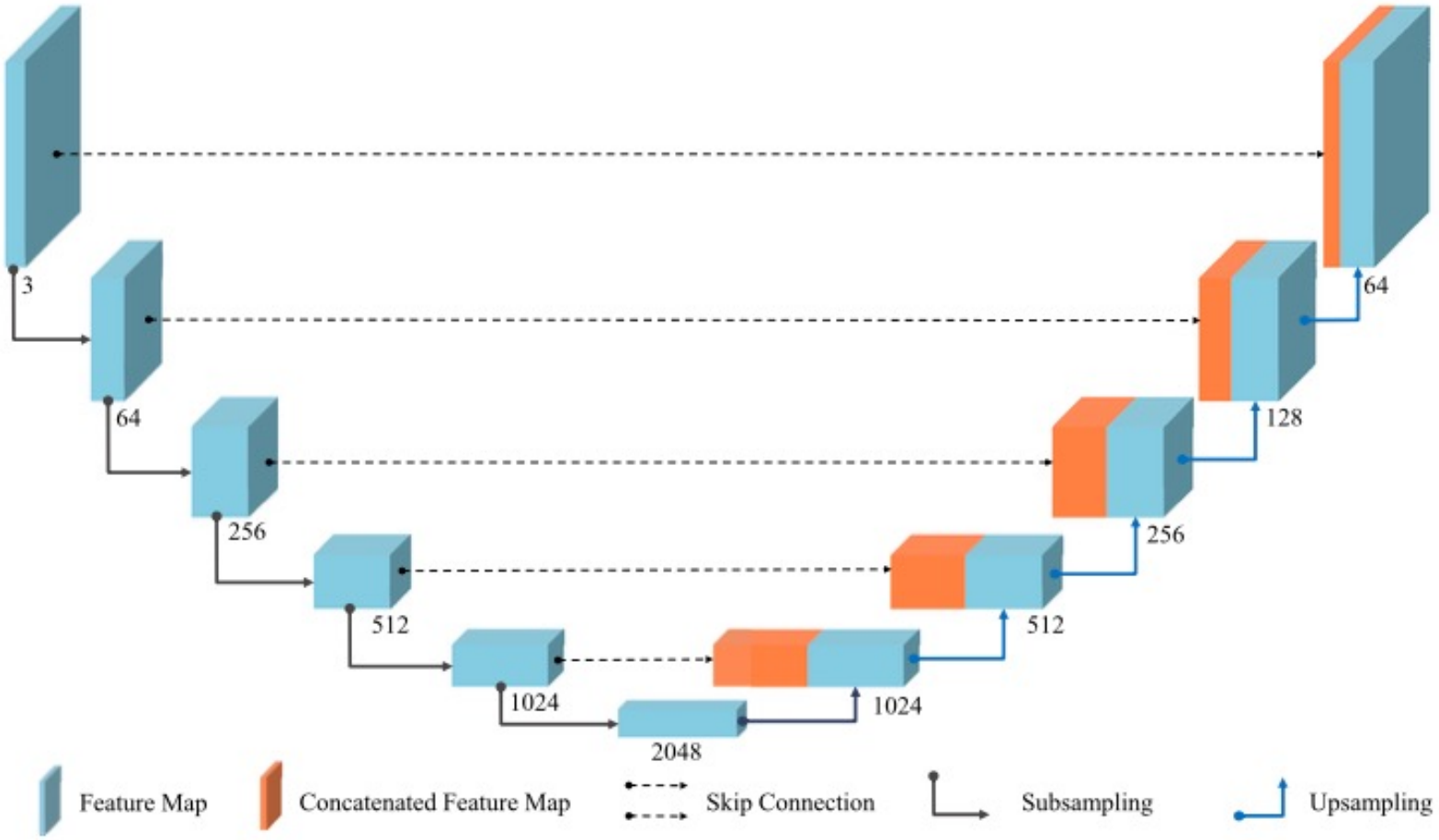


FIGURE 3. **The basic structure of the residual network.**

Decoder

- Unet



Design Loss Functions

The Adversarial Loss aims that the generator generates the reconstructed image as similar to the original image and improves the discriminator's ability to distinguish the original image and the reconstructed image.

- **The Reconstruction Loss** to ensure that the generator can produce a reconstructed image that is identical to the original image and better captures the normal distribution of the normal image.
- **The SSIM Loss**, The structural resemblance between two images is measured using the SSIM index, which may help represent the difference in structural detail between the restored image and the original image.
- **The Feature Loss** to ensure the original image x and the reconstructed image x^ are as similar as possible in the low-dimensional feature vector.

$$\mathcal{L}_{adv} = \mathop{\mathbb{E}}_{x \sim p_x} [\log D(x)] + \mathop{\mathbb{E}}_{x \sim p_x} [\log(1 - D(G(x)))]$$

$$\mathcal{L}_{rec} = \mathbb{E}_{x \sim p_x} |x - \hat{x}|_1$$

$$\mathcal{L}_{SSIM} = -\log SSIM(x, \hat{x})$$

$$\mathcal{L}_{feat} = \mathop{\mathbb{E}}_{x \sim p_x} |f(x) - f(\hat{x})|_2$$

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Evaluate the Proposed AI Models

- Evaluate the accuracy, precision, recall of the proposed models.
- Compare to the previous research. Find the key references.

- Ablation study
- Removing some “feature” of the model or algorithm, and seeing how that affects performance.
- For example: removing data preprocessing module and compare the accuracy to the original model.

Hope You can Be Expert of AI !!

expert.ai